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THE MODERN THEORIES OF THE NATURE AND ACTION OF TOXINS.

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The experimental study of the action and production of toxins and antitoxins, which has been so actively pursued in the last decade, has brought to light a large number of results which have a very wide, one might say startling, significance. These called loudly for an explanation which would render them intelligible. To furnish this explanation, a complicated structure of brilliant hypotheses has been involved, mainly by Ehrlich. These fulfil admirably the purposes of working hypotheses, in that they furnish a guide in experimentation and aid in grasping the facts. They have in this way proved themselves very useful. A clear understanding of them is therefore very important to every one who aims to keep in touch with the progress of natural science.

These theories attribute to the toxins and antitoxins properties which are familiar in ordinary chemical molecules, and the theories are most easily understood if they are treated and illustrated as chemical theories. This I have attempted in the present article. In its preparation I have availed myself very freely of the Huxley Lecture, delivered in 1902 by Prof. Wm. H. Welsh.¹ This gives a most comprehensive exposition, from the standpoint of pathology, of the overwhelming literature which has appeared on this subject.

¹ Published in the *Bulletin of Johns Hopkins Hospital*, 13: 285.

Toxins possess some very distinctive characters: They produce their actions in extremely small doses, being in this respect allied to ferments; they act, as a rule, specifically, *i. e.*, upon only a few structures; and they are destroyed by specific substances produced by cells, especially under the influence of the particular toxin.

Both the toxins and antitoxins are usually either proteid, or are so closely bound to the proteids that it has been impossible to separate them; they are, therefore, sometimes called "toxalbumins." It is doubtful whether any toxin has been isolated in pure form. Several have, however, been purified until they ceased to give proteid reactions. They still contained nitrogen. Most toxins are very sensitive to the conditions which alter proteids. They are often destroyed by even moderate heat. Many are also altered by ferments, so that they produce little action when introduced into the alimentary canal.

Toxins exist normally in the cultures (diphtheria, tetanus) or in the cells (pus organisms) of a number of bacteria; in some animal fluids (serum, snake venom); in some plants (jequirity and castor-bean), and in certain proteids (albumoses and peptones). Other toxins are produced by the body only through the stimulus of some foreign element, as by the introduction of cells, proteids or toxins, of a foreign species (or bacteria). These act then only on the substance which gave rise to their formation. When a substance of this class is useful to the body by destroying bacteria or their products, it is called an antitoxin. Antitoxins, therefore, differ from toxins only by acting on different structures. Certain bacteria similarly produce toxins only under the stimulus of the conditions existing in the living body. Other bacteria, as *e.g.*, anthrax, probably do not produce toxins at all, but act through the mechanical impediment which their numerous cells introduce into the circulation.

The effects of toxins (including so-called antitoxins) are generally exerted upon only one or a limited number of cells or substances. They consist in: Injury cells, as shown by the cessation of movement, morphological changes, or death (toxins producing such actions being classed as cytotoxins), or even by solution of cells (cytolysins), agglutination of cells (agglutinins), precipitation of substances (precipitins), coagulation (coagulins), neutralization of other toxins (antitoxins), or of ferments (antienzymes). These

classes are further subdivided according to the structure upon which the toxins act specifically. These subgroups are distinguished by such self-explanatory terms as leucotoxins, spermatotoxins, hemolysins, hemagglutinins, etc. A further very important effect of toxins consists in their leading to the formation of antagonistic substances.

To explain these effects of toxins, we must premise some conceptions of the chemical processes of life.

The molecules of the substance which forms the chemical basis of life—the “biogen” molecules, as they are called—must be structures of the greatest complexity, composed of enormous numbers of atoms. It has been truly said that the composition of the biogen is constant only in the sense in which the composition of a flame is constant. Whilst the ratio of the atoms may remain unaltered, the individual atoms are ever changing their position and relations. The most characteristic feature of biogen is its metabolism—the fact that it assimilates molecules which are foreign to it. This presupposes that the structure of the biogen molecule is of such a nature that it can readily add other molecules. It must have unsaturated or loosely saturated affinities. In order that two molecules can combine they must have affinities for each other. These affinities do not reside in the molecule, but in certain of its atoms or groups of atoms, so-called side-chains, just as in the benzol ring, substitutions do not occur in the entire molecule but in the H atoms or other side-groups. These side-groups, corresponding to the H₂ atoms of benzol, or to the CH₃ of toluene, etc., are called “receptors” in the case of the biogen. The fact that the biogen molecule can combine with almost innumerable substances, proves that it possesses a large number and variety of these side-chains. The almost infinite number of such reactions, which have been demonstrated or forecast, makes it probable that the biogen molecule does not only possess a large number of receptor side-chains, but that these are capable of such readjustment that they may develop affinity for almost every conceivable reagent. It is plain that these open side-chains or receptors—as we shall henceforth call them—are of the utmost importance to the cell, since they are prerequisite to metabolism. Their saturation by food-molecules does not lead to an appreciable diminution of them, since the receptor food-molecules

are quickly broken down again, the receptor again becoming unsaturated; but if a receptor is saturated by a molecule which does not break down again, that receptor is lost to the biogen. This seems to happen when the reagent is a toxin.

We have seen that a complex molecule takes up other molecules only into its side-chains. The same fact may be stated in other words: a complex molecule does not unite with another molecule except by its side-chain. A potentially toxic molecule often cannot act upon biogen, because it has no appropriate side-chain by which it can enter into a biogen combination. If now such a side-chain is introduced, the possibility of combination, and thereby of action, is given. For instance, C_6H_6 has potentially the toxicity of the coal-tar antiseptics; but having no affinity for biogen it cannot exert its action. Hydroxyl OH has considerable of this affinity, but its action is quite weak, and totally unlike that of the coal-tar series. If the OH is introduced into the C_6H_6 —producing carbolic acid—we obtain at once a great toxic and antiseptic action, because now the benzol molecule can unite with the biogen molecule through the intermediation of the OH. To anticipate the terminology of toxins: C_6H_6 is the toxic complement; OH is the intermediary body.¹ Now, in the case of toxin action, both classes of constituents must be present—a toxic complement which contains the potential toxic action, and an intermediary body which is necessary to bring this potential action into execution; and besides these there must be a fitting receptor or side-chain in the biogen to which they may attach themselves. A very great diversity exists as to the source of the first two components. The foreign toxin may contain both the toxic complement and the intermediary body; or, it may contain either the toxic complement or the intermediary body alone, the other ingredient being furnished by the biogen, or from some other extraneous source, as, for instance, by the serum in cases in which the toxic action is on the blood-corpuscles.

¹ To illustrate or emphasize certain features of the hypotheses, a large number of nearly equivalent terms are commonly used. These often differ a shade amongst themselves; but as their meaning has altered somewhat with the evolution of the theory, and as they are often rather loosely interchanged, they are apt to give rise to much confusion. These synonyms are:

Receptor.—Haptophor, side-chain, amboceptor.

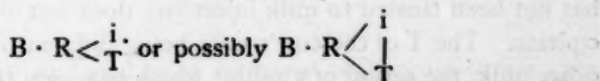
Toxic Complement.—Complement, alexin, cytase.

Intermediary Body.—Toxiphor, immunizer, sensitizer, fixative, preparative, copula, desmon, toxoid, amboceptor.

There is still another important fact which must be mentioned: Experimental data show that the intermediary body is not necessary for the *combination* of the receptor with the toxic complement. The receptor may combine with either the toxic complement or the intermediary body alone; in this case no toxic action will result. In order to have a toxic action, the receptor must combine simultaneously with both these elements. In other words, we must conclude that the receptor has two unsaturated affinities (hence "amboreceptor"), whilst the toxic complement and the intermediary body have each only one affinity. If only one of the affinities of the receptor is saturated, either by an intermediary body or by a toxic complement, this will not interfere seriously with the biogen; but if both are saturated simultaneously by a toxic complement and by an intermediary body, the receptor is rendered useless, as already explained. And if the toxic molecules are sufficiently numerous to saturate most or all of the receptors, the biogen must be destroyed, since unsaturated receptors are essential to its nutrition, and thus to its life. Since the biogen contains a very large number of actual or potential receptors, the result of the saturation of one or a few of these is not necessarily fatal to the biogen. Indeed, as may be seen in tissues, a small injury often serves as a stimulant, and in this case it leads the biogen to regenerate the lost receptors. It even goes further and regenerates these receptors, or whichever of its groups have been lost in excess, and discharges these into the exterior, into the serum. The serum charged with these receptors has now the power to bind toxins, and is therefore "antitoxic."

The facts will be much more readily understood if we substitute symbols for the terms, and represent the reactions as we would in chemistry.

Let B = the main biogen molecule; $R <$ one of its receptors with its two unsaturated affinities; — T the toxic complement; — i the intermediary body, each with one affinity. The normal biogen molecule would then stand: $B \cdot R <$; the poisoned molecule



The following cases occur:

(a) If the toxin contains both i and T , it can enter directly into combination with $B \cdot R <$. If an antitoxin is produced, this must consist of $R <$.

(b) If the toxin contains only T, the body must furnish i; if an antitoxin is produced, this must consist of

$$R <^i$$

(c) If the toxin contains only i, the body must furnish T; the antitoxin must be

$$R <_T$$

The first case occurs with diphtheria and tetanus toxins; these contain both the T and the i molecules; the last occurs with snake venom, which contains only i. The second case occurs with most bacteria which do not form soluble toxins in cultures; as also with the formation of precipitins, etc., by the injection of living foreign cells or substances.

An example may make this clearer: The milk of a cow, when it is injected under the skin of a rabbit, acts toward the biogen of the rabbit as if it contained a T-group.

This group, combining with the

$$R <^i$$

of the biogen, stimulates these to an overproduction of

$$R <^i$$

molecules, which are discharged into the serum. These molecules have the power of combining with the T-molecules of the milk. This fact is shown by the production of a precipitate when the serum of a rabbit thus treated is added to a sample of cow's milk. This

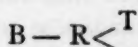
$$R <^i$$

is therefore called a "precipitin." The serum of a rabbit which has not been treated to milk injections does not produce this precipitate. The T of the cow's milk being different from the T of any other milk, the serum of a rabbit which has been treated with cow's milk will not precipitate, *e.g.*, goat's milk. Nor will one treated with goat's milk precipitate cow's milk. Since the proteids of an animal do not contain any molecules which act as T toward the cells

of that species of animals, the injection of rabbit's milk into a rabbit would not lead to a production of a precipitin.

The production of toxins and antitoxins through the overprolific regeneration of saturated side-chains form a plausible theory to account for the non-toxicity of the sterile cultures of many bacteria, as those of typhoid, cholera, etc. There can be little doubt that these, as well as diphtheria and tetanus, act by the production of toxins. The absence of such toxins in culture has been explained by several theories: It may be assumed that the culture media are unfit for toxin formation; that the toxins are very firmly bound in the bacterial cells, and are only liberated on the disintegration of these cells; or finally, that the toxins are only produced in considerable amount in the contest of the bacteria with the tissue-cells. Whilst there is probably considerable truth in the first two explanations, the last accords best with the theories which we have studied.

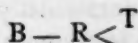
It will be recalled that toxins and antitoxins do not differ in their nature; the terms refer merely to the damage or protection to man. The biogen of the bacterial cells behaves precisely like the biogen of a man, and from the standpoint of the bacterium, the terms of toxin and antitoxin are precisely reversed. It reacts to what we call antitoxin, but what the bacterium would call toxin, in precisely the same way in which the human biogen would react—by the increased production of an antibody. Let us suppose that we introduce a colony of cholera spirilla into the circulation of an animal. The biogen of these bacteria may be represented as



In the culture medium these have produced a small excess of T, which goes into solution, so little that it cannot be demonstrated by ordinary tests—enough, however, to combine with the



of some body-cells and lead to an increased production of this complex. This now combines with the



of the bacterial biogen, saturating the receptors, and leading to the overproduction of bacterial

$$R < T$$

groups. A *circulus viciosus* is thus established, which will continue until either the *i* or the *T* obtains the upper hand, when the circle will turn in the other direction, one or the other cell being killed.

This necessarily fragmentary exposition will suffice to show the general nature and scope of the side-chain theory. The few illustrative examples will make clear how this theory can furnish satisfactory explanations of the facts now known to us. It must not be forgotten, however, that the conceptions upon which these hypotheses are based are as purely symbolical as is the hexagon by which we represent the benzol molecule.

NOTES ON SYRUPS.

BY FREDERICK W. HAUSSMANN.

The phenomenon of caramelization is not solely confined to syrup iodide of iron. Other syrups, as well as saccharine preparations containing metallic salts, show a similar effect on standing. Syrup of ferrous bromide is an illustration, as well as the very frequent experience, that syrups containing free acids gradually turn dark. Recently the writer observed that caramelization takes place in syrups containing salts of manganese and a number of similar illustrations may be cited.

The question, why caramelization does not take place immediately upon preparing syrup ferrous iodide directly from sugar, may be answered that it will take place if the syrup is heated to excess.

Recent researches have shown that metallic salts cause inversion of sugar in solution, and this is very probably the cause of caramelization in syrup of iodide of iron and other saccharine preparations.

SYRUP OF THE HYPOPHOSPHITES.

Considerable difficulty is occasionally experienced to obtain complete solution of the calcium hypophosphite in preparing this syrup.

Even if the insoluble residue is triturated with hypophosphorous acid, some insoluble material still remains.

Complete solution will, however, take place on prolonged standing. If the salts, previously well triturated with the hypophosphorous acid, are in contact with the full volume of water directed by the Pharmacopœia, complete solution will be effected on standing twenty-four hours.

In preparing the syrup by agitation, it is frequently observed that upon the addition of the sugar to the filtered solution of the hypophosphites, a crystalline deposit takes place in the syrup.

This is not always the case, as some syrups will keep almost indefinitely.

This phenomenon appears to be dependent upon the quality of the calcium salt.

Some manufacturers, putting up the salt in cartons, request transfer to impervious containers immediately on receipt, stating that the article is decomposed by exposure. It is also stated in some text-books that syrup of the hypophosphites is oxidized on standing. An examination of the precipitate in several specimens of cloudy syrup showed that it was merely redeposited calcium hypophosphite.

The singular feature is, that syrups prepared from the calcium hypophosphite of certain manufactures invariably precipitate, while the salt, procured from other sources, furnishes a stable preparation.

The question arises here, If saturation of the aqueous solution with the sugar does not cause precipitation of the calcium salt, or if other causes underly this change?

SYRUP OF IPECAC.

While making 5,000 c.c. of this syrup, with strict observation of the official directions, it was found that the finished syrup measured nearly 5,200 c.c. A second trial, in which 1,000 c.c. were prepared, confirmed this result, as the final volume was found to measure between 1,035 and 1,040 c.c.

The cause of this error, which results in a slight decrease in the strength of the syrup, is found in the pharmacopœial directions, which are approximately as follows: Dilute 70 c.c. of fluid extract of ipecachuana with 300 c.c. of water previously mixed with 10 c.c. of acetic acid, shake, filter the mixture and pass enough water

through the filter to measure 500 c.c. To this liquid add 100 c.c. of glycerin, and dissolve in it 700 grammes of sugar.

The volume of the filtrate—500 c.c.—is excessive, and should be reduced to 450 c.c., when a syrup can be prepared, the finished volume of which will not be in excess of the official limit.

SYRUP OF WILD CHERRY.

A number of specimens of syrup of wild cherry, which were prepared in the latter part of 1899, and the early months of 1900, were recently examined as to their state of preservation.

As some were made with menstrua containing various percentages of acetic acid and glycerin, a comparison with syrups containing no acetic acid was deemed of possible interest.

The infusions, from which the syrups were prepared, were also preserved and show, as may be expected, various forms of decomposition.

All syrups, in the preparation of which an acetic acid menstruum was employed, contained a reddish precipitate. A specimen, prepared with a menstruum of 1 per cent. acetic acid and 5 per cent. of glycerin contained a heavy red-brown deposit, which is also the case, although to a less degree, in a syrup containing 10 per cent. of glycerin.

Syrups containing 2 and 3 per cent. of acetic acid and 10 per cent. of glycerin in the extracting menstruum show the greatest stability.

A syrup which was prepared with diluted acetic acid, without any glycerin, was found to be an unsightly preparation.

All syrups containing acetic acid possessed a peculiar odor.

Three specimens of the syrup, prepared without acetic acid and containing respectively 5, 10 and 15 per cent. of glycerin, the latter the official amount, were found in a good state of preservation. The 5 per cent. syrup was found to have a red deposit, while in the others precipitation was slight.

This would indicate that glycerin is necessary as a preservative of wild cherry syrup; that it must be a part of the percolating menstruum and that the amount should be at least 10 per cent. of the syrup.

THE MICROSCOPIC STUDY OF URINE, TECHNIQUE FOR PERMANENT MOUNTS AND METHOD OF MAKING RECORDS.

BY L. NAPOLEON BOSTON, A.M., M.D.

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Due to the variable number of gateways through which error may pass in the microscopic analysis of the urine, a careful systematic technique sufficiently broad in its scope that it may be bounded on the one hand by the method for the collection of the specimen, and on the other by the ultimate results of such studies, is needed. Give the amateur microscopist such a guide and he can soon equip himself with a collection of specimen slides, equal in every way to those I shall exhibit this afternoon; moreover, he will acquaint himself so thoroughly with these specimens from their repeated study, that the knowledge of them becomes a part of himself and ceases to be one of question.

METHOD FOR COLLECTING AND PRESERVING THE GROSS SPECIMEN.

(1) Collect from that urine voided two or three hours after the heaviest meal of the day, or after active exercise. Urine passed on rising after a night's sleep is seldom of microscopic interest.

(2) The urine should be voided in a clean vessel—collect the specimen in a clean bottle and add five (5) drops per ounce of chloroform. I have found chloroform to be a most valuable agent in preserving the organic elements. The reaction of a urine governs largely its microscopic findings; for example, casts are soon destroyed by an alkaline medium, and urine, alkaline as a result of fermentation, is apt to display a heavy precipitate of phosphates when the total amount of phosphates present is not above the normal. Ammonium urate crystals appear in the same manner, and yet neither substance bears any clinical significance except when displayed by the fresh specimen. Acid urine may contain casts, oxalates, uric acid, amorphous urates, acid phosphates and crystals of bile acids; but I have never been privileged to study any of these substances in a decidedly alkaline specimen. Many sediments do not depend in any measure upon the chemical reaction, as is shown by such substances as pus.

METHOD FOR STUDY.

(1) Invert the bottle two or three times to insure that the sediment is perfectly disseminated through the urine, when a small quantity of urine is placed in a special tube and centrifugated for from 2 to 5 minutes. The machine is not absolutely necessary, and for practical work the urine can be allowed to stand in a cool place for 6 to 12 hours, when ample sediment will have collected at the bottom of the bottle.

In case the sediment is to be mounted as a permanent specimen, decant clear supernatant urine, and add an equal quantity of water in its stead and again sediment, repeating the process until this sediment is thoroughly washed.

(2) Sediment, however obtained, is lifted by means of a wide-mouthed pipette, and a small drop of it placed on the centre of a slide. The specimen is now viewed through a $\frac{2}{3}$ lens to determine its value; and should the subject be one worthy of preservation, the above method of washing having been employed, the specimen is allowed to dry in the air, after which it may be mounted in Canada balsam. This method will be found of service for inorganic sediments, pus, blood, bacteria, fungi, and the ova of animal parasites. Casts and animal parasites, however, while collected in the same manner, must be mounted while yet moist (since drying causes disintegration) in a special medium composed of the following: Liquor acidi arseniosi (U.S.P.) 1 fluid ounce; salicylic acid, $\frac{1}{2}$ grain; glycerin, 2 fluid ounces. Warm slightly until solution is effected, when add acacia (whole tears) and again warm until solution is saturated. After subsidence decant clear supernatant liquid. The drop of mounting medium should always be of good size, since it requires a quantity for urinary sediments of twice that usually employed for sections. A perfect distribution of the sediment throughout the medium is accomplished by drawing a needle from the margin to the centre of the drop.

STAINING.

Place a small drop of the sediment on a slide and spread it over a large surface in order that the cells be separated; heat over a flame for three minutes, carrying the slide to the ulnar surface of the hand every few seconds. A guide, in fixing by heat, is never to raise the temperature above that which can be borne by the surface of the

hand, since a higher heat is liable to cause distortion of the cells. Staining is best effected by a solution of carbol fuchsin, methylin blue, Soudan III and iodine. The former of these solutions when employed without heat will be found to stain satisfactorily both bacteria and the tissue cells. When heat is applied and the specimen steamed, and later counterstained for three (3) minutes with Gabbetts blue solution, the tubercle bacilli will appear as bright-red segmented rods, while other pathogenic organisms will appear blue. Study of the gonococcus in the urinary sediment is very unsatisfactory, and I hesitate to recommend its pursuit. The various fungi (mycelium) are also found in urinary sediments, but are of limited clinical value.¹ Soudan III and iodine are of service in the detection of fatty and amyloid changes respectively. Spermatozoa when stained provide an interesting subject.

MICROSCOPIC STUDY.

Most important is a good microscope stand provided with a one-sixth and a two-third objective, an iris diaphragm and an Abbe condenser. I cannot urge too strongly upon the use of a thoroughly equipped substage, and must insist that the finer and more valuable features of urinary microscopy are passed unrecognized by the person who is not thoroughly trained in the use of the diaphragm and of the condenser. Let it suffice to emphasize that a small amount of light should be employed in the study of urine. It is my custom to devote three hours of the college course exclusively to the manipulation of the microscope; yet this time has proven to be insufficient for the instruction of students in the workings of an instrument essentially so delicate and susceptible to error.

Specimens should first be examined under a two-third lens, and by careful moving of the slide the entire specimen is viewed quickly. All questionable bodies are brought to the centre of the field, when the one-sixth lens is brought into focus. Much time is lost in searching over a specimen with a high-power lens, and any examination is always far from perfect unless the two-third lens is used as a finder.

THE MAKING OF RECORDS.

The mixing of specimens is a common source of annoyance and may be avoided by use of the following blank which I have found

¹ *Philadelphia Medical Journal*, 1901, p. 446.

to meet the demands of daily clinical work. The following blank is $8\frac{1}{8} \times 5\frac{7}{8}$ inches.

URINE ANALYSIS.

Name,
Residence,

A. M.
P. M.

PHYSICAL AND CHEMICAL EXAMINATION :

Amount in 24 hours,	Bile pigment,
Sp. gr.,	Uric acid,
Reaction,	Urea,
Color,	Sulphates,
Transparency,	Phosphates,
Sediment,	Chlorides,
Froth,	Diazo-reaction,
Albumen,	Minerals,
Sugar,	

MICROSCOPIC EXAMINATION :

(a) Organized Sediment.

Casts,	
Epithelium,	Red
	Blood {
Shreds,	White {
Bacteria,	Pus,
Other products,	Parasites,

(b) Unorganized Sediment.

Crystalline :	Amorphous :
Uric acid.	Urates,
Calcium oxalates,	Phosphates,
Triple phosphates,	Debris,
Ammonium urates,	

Examined by

Date,

+ and — designate present and absent.

(Remarks over)

(1) The name and address are written upon the blank, the blank laid upon the table and all bottles belonging to it are stood upon the top of the blank. Whenever a bottle is removed from the blank it should be returned before another bottle is taken from the table.

(2) In the centrifugating of urines one of the machine's tubes is surrounded at its top by a small elastic, and upon the blank to which the urine in this tube belongs place the letter R, and upon the blank to which the urine in the plain tube belongs place the letter T. In this way, by special marking of the tubes, a machine with any given number of arms may be used without confusion.

(3) Immediately upon the removal of a tube from the machine its sediment should be lifted by means of a pipette and a drop placed on the centre of a slide, a cover-glass added and the slide placed upon the blank to which it belongs. While all the specimens are being made ready in this way for microscopic study, the chemical analysis may be done, allowing the microscopic study to wait until last.

(4) The slide is now placed on the microscope and the blank upon which there is no slide found is the one upon which to record the results of our study. The signs + and — are used in the making of records. Five plus marks are used to denote the greatest amount of a given substance encountered. These characters are also employed in recording acidity, froth, sediment, sugar and albumin, and have been found to facilitate materially in all clinical laboratory work.

THE LIFE-HISTORY OF A DOCTRINE.¹

BY PROF. IRA REMSEN.

This title suggests a biological analogy. The life-history of an animal includes a record of the events in the life of that animal from the earliest stages to the end—from birth to death. But there are events before birth. The life-history is preceded by the embryonic history, and there are events after death—events biological, as shown in heredity; events chemical and physical as shown in decay, and the reduction of the complex constituents of the animal to simple forms that can be assimilated by living things and thus enter again into the round of life. I do not refer here to spiritual events after death, for, in speaking of animals, I have not had man in mind, and it is customary, I believe, to deny to all animals, with this exception, the persistence of the spirit after death. In the analogy that I have in mind, however, the spiritual events are to be taken into account, for, as I think can be made clear, there is a life after death in the case of a good doctrine as in the case of a good man. The pursuit of this analogy is interesting (to me), but it will be more profitable to illustrate it by examples, of which there is no end. I wish especially to point out the bearing of the philosophy of the history of chemistry upon the present-day problems so far as this may be possible in the time at my disposal.

¹ Presidential address before the American Chemical Society, December, 1902, and reprinted from the *Jour. Amer. Chem. Soc.*, February, 1903.

The doctrine of the transmutation of metals played a most important part in its day. No one can trace it to its beginning. It is, however, clear, that it developed great strength and controlled the intellectual activities of the leading intellectual men of the world for several centuries. It led to the development of chemistry. The alchemists were the working chemists of their day. They taught the world the lesson that it is only by contact with the things of this world that we can gain knowledge of them. They laid the foundations of experimental science. The soul of alchemy was experiment. The fundamental doctrine of alchemy, transmutation, after a long and active life began to show signs of weakness; and in due time it took to its bed, and in spite of admirable medical care it died and was buried. No chemical doctrine has had anything like as long a life as this. To be sure, this could not have been possible, as the life-history of the doctrine of transmutation covered a period longer than that which had elapsed since its death, though it is difficult to fix the time of its death with accuracy. It is dead now at all events, and we may ask the question: What came after death? The doctrine accumulated large wealth and left the world a large estate. I need not give you the inventory. Probably no one can do so. But we do know that we owe to the activities of those who were controlled by the doctrine of transmutation a long list of substances that are of fundamental importance, such as sulphuric acid, nitric acid, phosphorus, alcohol, ether, etc. This is the material side of our inheritance. How about the spiritual? I have said that experiment was the soul of alchemy. That will live forever. I should perhaps have said that experiment was one of the souls of alchemy, for I suppose it is not objectionable to assume that a doctrine may have more than one soul. The rule in regard to human beings seems to be perfectly simple, and it is generally accepted, but I once heard of a professor, who, speaking of some great disaster, said: "On this occasion 300 souls perished—counting one soul to each body." Assuming that a doctrine may have more than one soul, I am inclined to think that a second soul of alchemy is to be found in the idea of the relationship between the elements—an idea that persists and keeps dangling before us the possibility of the transmutation, not only of base metals into gold or silver, but of all the elements one into the other from one end of the list to the other.

Let us take another doctrine—that of phlogiston. The embryology of this doctrine has not been clearly worked out, but its life-history has been traced pretty carefully. We know how it died and, in the events that followed, it is not difficult to find evidence of its existence after death. It was through the influence of this doctrine that chemists came to recognize the common features of those phenomena that we now group together under the general name of oxidation. They were all ascribed to one cause, a subtle substance, phlogiston. The search of this substance became the great problem of chemistry. The possibility of finding it was a great incentive to work. What matters it that the doctrine of phlogiston became aged and died and was buried? It did good service—ineestimable service: It kept its disciples at work and led them through this work nearer and nearer to the truth. In its life it passed through the period of infancy with all its attendant dangers, through the period of enthusiastic youth, through sturdy manhood, and it reached old age with its attendant signs of weakness and decay. It died at last, but only after a mighty struggle. The act of dying was prolonged. Since then generations of astute teachers of chemistry have pointed out to their perhaps even more astute scholars the errors of phlogisticians, and they have all smiled and wondered how these deluded men could ever have been deluded. Possibly they forget that those at whom they smile were the leaders of their times, and that these leaders were trying as earnestly as the chemists of our own day to learn the truth.

What is the spiritual part of the doctrine of phlogiston that lives after its death? Clearly it is the idea that all the phenomena of combustion, including calcination, have a common cause. That cause has, to be sure, been shown to be oxygen. The phlogisticians thought that the cause was phlogiston, a purely imaginary substance. Priestley and Scheele and Lavoisier showed that it is an invisible gas working quite differently from the way the phlogisticians supposed. The life of the doctrine of phlogiston left us richer in material possessions and in ideas. The discovery of oxygen, which is, no doubt, the most important discovery ever made in the field of chemistry, tended to give a materialistic trend to the thoughts of chemists. Both the philosopher's stone and phlogiston were imaginary substances that were sought in vain. Although both have been described by enthusiastic, but inaccurate, and per-

haps mendacious workers and writers, neither of these subtle things could be found. It was, nevertheless, possible to believe in their existence and to indulge in the hope of their discovery. But now oxygen came on the scene. Indeed, it may be truly said that it took possession of the stage, and it has been playing the leading part in the field of chemistry ever since. Here is an invisible substance existing in the air and capable of bringing about the most astonishing changes in things. We cannot realize the effect of this discovery upon the thoughts of chemists. I sometimes feel that I should like to have lived as a chemist in the latter part of the eighteenth century. What thrills the workers of that time must have felt when they heard of the discovery of oxygen and learned from Lavoisier what part it played in combustion! We sometimes plume ourselves upon the doings of our own times. Has there ever been a more active or more fruitful period in the history of chemistry than that wonderful period here referred to?

It was a great step forward to show that oxygen is one of the most powerful agents at work in the processes that are in progress on this earth. Not only combustion, but life in all its forms is in some way dependent upon it—animal life directly, plant life indirectly. Oxygen is the controlling factor in all the changes that are familiar to us. Some one, I do not know who, is responsible for that superficial and much-quoted phrase "Without phosphorus no thought." The same statement could be made with equal truth in regard to other elements, such, for example, as nitrogen, carbon, hydrogen, sulphur, sodium, calcium, and, above all, oxygen. Indeed, we may almost say, without oxygen no chemical activity on this earth. This sudden appearance of oxygen and the recognition of its importance tended to put matter on a throne. "The study of material things will lead to the discovery of the hidden causes of other phenomena. See what the discovery of oxygen has done for us! Here is something tangible. Let us to work. There must be plenty of other things that operate as causes. If we can only bring these things to light, we shall be able to understand what is going on around us." So must the materialists have thought. There were, however, in those days, as there probably always have been, those who looked for the power behind the throne on which matter had been placed. To drop the figure and return to oxygen we may say that, while the discovery of this element gave the answers to

many questions, it raised many new questions; and the attempts to answer these led again to regions of imagery.

One of the oldest tricks of the mind is the evoking of spirits in time of need. What causes all bodies to attract all others? We say gravitation, and somehow this spirit helps us. We feel as though we knew more about the phenomena of universal attraction when we have given a name to an imaginary and immaterial cause. So, too, when we inquire why oxygen causes the changes it is known to cause we can only conjure the spirits and give a new name. Oxygen unites with carbon; the carbon burns; a new thing is formed. It all becomes clear when we are told that it is chemical affinity that does it. Chemical affinity isn't an imaginary substance; it isn't something that we may see and handle. We haven't forgotten the philosopher's stone and phlogiston. Our imaginary cause is spiritual; it is not material. But this is a digression. It was intended to show how the mind reverts promptly to the subtle, however powerful the attraction of matter may be. We cannot, if we would, keep to things material.

Recalling, what perhaps even I have forgotten, that my theme is "The Life-History of a Doctrine," I propose, now that I have tried to show what is meant by this phrase, to move on more rapidly, so that I may dwell somewhat more fully upon one particular doctrine that has been before the chemical world in one form or another for about a century.

The discovery of oxygen did not lead directly to the introduction of a new chemical doctrine. Its chief result, so far as doctrine is concerned, was the death of the doctrine of phlogiston.

The discovery emphasized the importance of taking into consideration the weights of the things worked with. It was by this means that Lavoisier achieved his brilliant success. That weight was rather lightly regarded in earlier days may be seen from the following quotation, which is taken from an essay by Dr. Jean Rey, published in 1630:

"My chief care hitherto has been to impress on the minds of all the persuasion that air is heavy, inasmuch as from it I propose to derive the increase in weight of tin and lead when they are calcined. But before showing how that comes to pass, I must make this observation—that the weight of a thing may be examined in two ways, *vis.*: by the aid of reason, or with the balance. It is reason

which has led me to discover weight in all the elements, and it is reason which now leads me to give a flat denial to that erroneous maxim which has been current since the birth of philosophy—that the elements mutually undergoing change, one into the other, lose or gain weight, according as in changing they become rarefied or condensed. With the arms of reason I boldly enter the lists to combat this error, and to sustain that weight is so closely united to the primary matter of the elements that they can never be deprived of it. The weight with which each portion of matter was endued at the cradle will be carried by it to the grave. In whatever place, in whatever form, to whatever volume it may be reduced, the same weight always persists. But not presuming that my statements are on a parity with those of Pythagoras, so that it suffices to have advanced them, I support them with a demonstration which, as I conceive, all men of sense will accept. Let there be taken a portion of earth which shall have in it the smallest possible weight, beyond which no weight can subsist; let this earth be converted into water by the means known and practised by nature: it is evident that this water will have weight, since all water must have it, and this weight will either be greater than that of the earth, or less than it, or else equal to it. My opponents will not say that it is greater, for they profess the contrary, and I also am of their opinion: smaller it cannot be, since we took the smallest weight that can exist: there remains then only the case that the two are equal, which I undertook to prove. What is shown of this particle may be shown of two, three, or of a very great number—in short, of all the element, which is composed of nothing else. The same proof may be extended to the conversion of water into air, of air into fire; and, conversely, of the last of these into the first.”

The idea that a thing can be weighed by reason is, I suppose, an inheritance from the old philosophers who seem to have believed that all the problems of the universe could be solved by mental operations, or that any problem that could not be solved in that way was not worthy of their consideration. The first great generalization that was reached after the method of weighing was generally adopted by chemists was what we sometimes call the law of the indestructibility of matter, or, in more refined language, the law of the conservation of mass. Then followed the laws of definite and multiple proportions. Now, a law of nature is quite a different thing

from a doctrine. A law once discovered does not wither and die. It is eternal. Such a statement cannot be proved to be true. It calls for faith, but faith is called for at every turn in scientific matters as well as in spiritual. Without it progress would be impossible. As I am trying to deal with doctrines and not with laws, let me say that doctrines call for even a larger faith than laws. The very essence of a doctrine is faith in things unseen. The discovery of the laws of definite and multiple proportions led to the thought of atoms—not the evasive atoms of the Greeks, but atoms that could, in a way, be made the subject of experiment—the Daltonian atoms. This conception appeals to some minds very strongly. It is not necessary that we should know what the atoms look like, though this is highly desirable. The atom of chemistry can accomplish the purpose for which it was conceived by Dalton by simply standing for a unit of matter that can pass unchanged, so far as mass is concerned, through a series of chemical changes. That is all we need to think of under ordinary circumstances. Some refined thinkers have found mental objections to the atom and it has been the subject of innumerable attacks. It doesn't do some things that it appears to us it ought to do and we try to depose it from time to time. Particles that cannot be more than 0.001 of the size of an atom challenge the right of the latter to supremacy, and the novelty-seekers, the born iconoclasts, cry out, "Make way for the corpuscle; the atom has had its day." But, seriously, the corpuscle does not seem to threaten the atom of to-day or of the immediate future—say any time within the next million years. The atom may be composed of corpuscles. Indeed, I think chemists would rejoice to learn that this is the fact. On this point, let me quote J. J. Thomson, the father of the new corpuscle. Speaking of Lenard's observation that the penetrating power of the corpuscles depends only on their density, he says: "This is exactly what would happen if the atoms of the chemical elements were aggregations of a large number of equal particles of equal mass, the mass of an atom being proportional to the number of these particles contained in it, and the atom being a collection of such particles through the interstices between which the corpuscle might find its way." Since the density depends only on the number of particles in unit volume and is independent of the nature of the resulting atoms, Lenard's result is a strong confirmation of the view that the atoms of the elementary

substances are made up of simpler parts all of which are alike." I am as yet unable to form a judgment in regard to the value of the evidence thus presented, but my confidence in J. J. Thomson gives me faith in the thoughts suggested by him. As I understand it, the worst that can be done for chemistry by the corpuscle is to change the atom so slowly that it would take something like a million years to enable us to detect the change by the balance. Perhaps the atomic weights of the elements, or of some of them, are undergoing change. Whether in the course of geological ages the atoms are becoming simpler or more complex is a question that appears idle at first, and yet when we bear in mind the fact that the atoms of our day have already been subjected to a great variety of influences for ages past, and that the atoms that we know are comparatively complex, we may at least suspect that the tendency so far is toward complexity. But here we are face to face with a problem far beyond our powers—the *action of eons upon ions*.

Even if we assume the corpuscle, our conception is still materialistic, and we have to face the question, What is matter? That is a deep question—one of the deepest that can be asked. It is not difficult to show that all definitions of matter that have been given are totally inadequate; to show that matter is a product of the imagination; that we know matter only in so far as it affects the senses, and our senses are affected only by the different forms of energy. By logic we can easily, with Ostwald, reach the conclusion that "matter and energy are not to be thought of as distinct, as, for example, body and soul." We cannot help agreeing with him further when he says: "If we attempt to think of matter as separate from the various forms of energy nothing is left. Matter is, in fact, nothing but a group of different energies in space." But what is energy? This question would have been promptly referred to the physicists by the older chemists, but the chemists of to-day are physical chemists or chemical physicists, and they grapple with such questions without reserve. Perhaps the nearest approach to an answer is that of Herz, who, according to Ostwald, "expressly declines to see anything in the electro-magnetic theory of light but a system of six differential equations." By means of mathematics, relations may be expressed and the story of nature told in a way that is clear to one who understands the language, and perhaps the time will come when men will have a complete record of the various forms of

activity of nature, and they may then see that our mechanical and materialistic conceptions of natural phenomena are like the rude drawings of a child as compared with the paintings of Raphael. We have glimpses of such a scientific millenium in a few nooks and corners of physics. When that time shall come the physicists and chemists will in a way be superfluous. Everything will take the form of mathematics. By mental operations alone it will then be possible to solve such problems as may remain to be solved. It will then no longer be necessary to work with things—or rather with those manifestations of energy which in by-gone ages (say the twentieth century) had been crudely interpreted as indicating the existence of matter. A few models of molecules, of atoms, of corpuscles, and, I fear I must add, of ions may then be preserved in the archaeological institutes for the contemplation of mathematical philosophers.

What I have just said has not been intended as a criticism of any tendency. I have had that vision as others have. So, too, I have had visions of a heavenly kingdom to come, and I am thankful that this has been vouchsafed to me. But that heavenly kingdom is far away and so is that scientific millenium. Meanwhile there is work to be done here on earth and with earthly things. If we were all angels, a good many problems that now worry us would be solved—never to be solved again. So, too, in that scientific millenium such work as scientific men now do will not be called for. I sometimes think that the man with the distinctly mathematical mind must necessarily be unhappy if he applies himself to the study of natural phenomena. The points of contact between his language and the facts established are relatively so few that he must have sensations like those of a man with large wealth in a desert island. I once knew a young mathematician, even then distinguished, who had made something of a study of physics. He needed to add to his income and an opportunity offered itself to him to coach some students of physics. He tried this and had to give it up. One evening I found him in great distress. He told me that he had been trying to explain the law of falling bodies to his scholars and had failed to make any impression on them. He confessed that he himself had no conception of the significance of the law except as it appeared to him in a mathematical expression. He could not think of a falling body as such. The mathematical expression

$$\frac{dx}{dt} = gt + \text{constant},$$

however, made all clear. He tried to convey his own thoughts to his students and he was greeted with open-mouthed wonder. So, too, I knew a physicist who approached his problems in much the same way. He would not let his class of beginners work with a lever and deduce the law from the results of their own experiments, which to me appeared an instructive exercise, "for," he said, "the lever is a mathematical instrument and it is not necessary to experiment with it in order to determine the laws of its action."

On the other hand, I have been told that Lord Kelvin says he cannot form a clear conception of any natural phenomenon without the aid of a model. I remember years ago, when he was lecturing at the Johns Hopkins University, that he showed his hearers a beautiful model of light waves, and I am sure they had the power to convey light to a number of brains that would have been in darkness if any other method had been adopted. Whether we will or not, we have the non-mathematical mind to deal with, and this brings me back to chemistry and that special doctrine of chemistry that has to deal with atoms.

The doctrine of atoms is still alive, though it came into being about a hundred years ago. It has been proved to be illogical, as the ether that fills all space has been shown to be incapable of existence. Properties must be ascribed to the atom that it cannot possess and the same is true of the ether. What are we to do? Throw over the atom and the ether? Although both have been convicted of being illogical, I do not think it would be logical to give them up, for they are helpful in spite of their shortcomings, and in some way they suggest great truths. They are symbolic. It would be as illogical to give them up as it is, in my opinion, to deny the existence of a power in the universe infinitely greater than any of the manifestations familiar to us; infinitely greater than man; a power "that passeth all understanding." The atom helps us; the ether helps the physicist. We cannot give them up without losing our hold on many phenomena. For a century the phenomena of chemistry has been interpreted in terms of atoms. Take away that conception and, though it would be possible to deal with these phenomena, I cannot believe that they would appear as clear as they now do. In an address before the chemical section of the British

Association for the Advancement of Science last summer, Professor Edward Divers took as his theme "The Atomic Theory without Hypothesis." Let me quote a few passages from his address. He says: "The atomic theory of chemistry stands unsurpassed for the way in which it has fulfilled the purpose of every great theory—that of giving intellectual mastery of the phenomena of which it treats. But in the form in which it was enunciated, and still is universally expressed and accepted, it has the defect of resting upon a metaphysical basis, namely, upon the ancient hypothesis that bodies are not continuous in texture, but consist of discrete, ultra-minute particles whose properties, if known, would account for those of the bodies themselves. Hence it has happened that, despite the light it throws upon the relations of chemical phenomena and the simple means it affords of expressing those relations, this theory has always been regarded with misgiving, and failed to achieve that explicit recognition which its abounding merit calls for. Indeed, the desire has been expressed to see the time when something on a more solid foundation shall have taken its place." Professor Divers thinks that in dealing with chemical phenomena we can avoid thinking of discrete particles of matter. The law of constant proportions is, to be sure, entirely comprehensive as a law without the aid of the atomic theory, and so is the law of multiple proportions, but can we possibly, as yet, co-ordinate them without this aid? I do not think I can, and this doesn't worry me. The kind of atom that my mind's eye sees seems to help me, but that eye has not troubled itself with other attributes of the atom than that one which is needed. It will be remembered that in Dalton's time it was proposed to substitute for the atom the equivalent, and some even wanted to use the conception of combining numbers. This last conception appeals to the systematic mind at first, but one cannot go very far with it without tacitly accepting the atomic theory. On this point Professor Divers says: "Refusing to commit themselves to belief in the hypothesis, chemists have thought from the first to escape the adoption of the atomic theory by putting Dalton's discovery into something like these words: Numbers called proportional or combining numbers can be assigned to the chemical elements—one to each—which will express all the ratios of the weights or masses in which substances interact and combine together. "Perhaps," says Professor Divers, "the atomic theory is successfully set aside by expressing what is an

actuality as an unaccounted-for possibility. But then those who use any such mode of expressing the facts without reference to the theory never fail also to adopt the doctrine of equivalents, and thus, by this double act, implicitly give in their adherence to the theory."

While the atomic theory can be used without using atoms, this must involve a great effort for the average mind. Why should we make the effort? If we can get a broader and deeper and clearer view of chemical phenomena by making the effort, by all means let us make it. Can we? That is the whole question. Apparently, not enough chemists have made the effort to furnish us with the necessary data upon which to base a conclusion. I should like to ask a dozen chemists to give me each his idea of the atom. The results would be interesting. Some years ago I sat next the late Bishop Brooks at a dinner party, and I had an extremely interesting conversation with him. I remember many things he said and, as having some bearing on the question I am now dealing with, I quote this remark: "I am sure," he said, "that every individual has a different conception of God. If we could get at these conceptions we should probably be greatly surprised to find how markedly they differ from one another." Each individual injects his own personality into his conceptions, and the conceptions change according to circumstances.

At first, weight, or, more accurately, mass, was the only attribute of the atom that needed to be taken into consideration, except, of course, that power of combining with other atoms which is its fundamental attribute. Soon after the atom came to be a part of the chemist's equipment two important attempts were made to add electrical charges to the atoms. Davy and Berzelius took different views of the way in which the electrical charges led to chemical acts, but they both agreed that chemical acts are essentially electrical. Every atom had not only weight, but an electric charge which did not add to its weight, but helped to explain its activity. The atom bore this charge for many years. It was thought that it gave it up and returned to its original simple form when the dualistic conception of the constitution of compounds gave way to the unitary conception. When it was found that chlorine, an electro-negative element, could take the place of the electro-positive hydrogen without creating any marked disturbance, chemists thought it best to turn

their backs on the electro-chemical theory. In fact, the old electro-chemical theories in their original forms were untenable, but this is quite a different thing from saying that electrical charges have nothing to do with chemical action. It appears to-day that these electrical charges are the controlling factors in chemical phenomena—but of that farther on.

The next change that took place in the conception of the atom was that which followed the discovery of Frankland that there is a limit to the number of atoms that can combine with any other given atom. This was followed up by Kekulé and the doctrine of valence was the result. Atoms differ from one another in respect to the number of other atoms with which they can combine. It would be interesting to follow the life-history of this doctrine of valence. It has had a most eventful career. It has been chastened by experience, and now it appears to us freed, to a great extent, from the faults of youth. It is far from dead. Indeed it is probably at the beginning of its career. The phenomena of valence must be reckoned with, and the study of these phenomena carries us back to the atoms and leads us to seek in them the causes of the differences in the composition of the compounds which are formed by their union.

It has unquestionably been shown that the original form of the doctrine of valence is not tenable. Elements cannot be classified rigidly under a few heads as univalent, bivalent, trivalent, quadrivalent, etc., nor can we hold the other view that all the elements have either an even number or an odd number of valences or bonds, though there appears to be some truth in this latter view. The artiads and perissads of our youth may return to us, but before they are received it will be necessary for us to ask them a few questions, and for them to answer them satisfactorily. In fact, we have learned that the phenomena of valence need to be studied carefully before we can discover the laws that govern them. The views that prevail to-day are but the foreshadowing of a broader conception of valence. This subject is very much to the front at present. The speculations of Werner with reference to complex inorganic compounds have awakened wide interest and have set many to thinking. One cannot ignore the mass of evidence put forward by Werner that tends to show that in many compounds it is necessary to assume the existence of a core or inner sphere consisting of a group of atoms in combination, this core holding in combination a definite

number of atoms or groups. Whether that which holds together the atoms that make up the core is what in similar compounds manifests itself as valence remains to be seen. At all events, if the views of Werner should prove to be correct, we shall have two kinds of valence to deal with—that of the inner sphere and that of the outer sphere, or that of the core and that of the shell. In a recent article Werner extends his views and introduces the conception of secondary valences. Thus he holds that in ammonia the three valences that enable the nitrogen atom to hold the three hydrogen atoms in the molecule of ammonia are different from that which enables ammonia to combine with a molecule of hydrochloric acid. The former he calls the "primary valences" (*Hauptvalenzen*), the latter a "secondary valence" (*Nebenvalenz*). He does not think that the two differ fundamentally. So Thiele in his study of the phenomena of saturation among organic compounds is obliged to assume the existence of "partial valences" (*Partialvalenzen*), and the facts described by him are singularly in accord with the assumption. This applies up to the present only to the compounds of carbon. Thiele's "partial valences" are, however, not to be confounded with the secondary valences of Werner or the other earlier "residual valences" of Armstrong. A discussion of this subject might be made interesting and profitable, but I cannot go into it here. So many curious valence phenomena have been observed of late that one cannot help feeling that we are about to have a revelation that will make the old as well as the new phenomena appear clear. Carbon is bivalent and quadrivalent. That has always been clear, though Nef has made it clearer than it used to be. But now comes trivalent carbon that Gombert has shown us, and we may be prepared for almost anything. And oxygen that has been regarded as a very model of bivalency these many years is getting restless, and is beginning to show that it too can do the unexpected. It seems clear that it can act as a quadrivalent element, but, according to Walden, it has even higher powers.

Whatever may come of all this, it is clear that we cannot enlarge our conception of the atom. It not only has the power to combine with other atoms, but under given conditions it has a definite number of such powers. If we attempt to represent these powers to our minds we can only use the grossest methods. The union of two univalent atoms does not necessitate the conception of direction.

But when two univalent atoms unite with one bivalent atom we can hardly avoid thinking of two points of contact on the bivalent atom and of two directions in which it exerts its powers of combination. This conception of direction is further forced upon us by a study of the phenomena of stereochemistry, especially in the field of the chemistry of the compounds of carbon. But, if the carbon atom exerts its powers of combination in definite directions that can be determined by observation, it is, to say the least, highly probable that all other elements act in the same general way, and indeed many facts have been discovered within the last few years that have given a clue to the stereochemistry of nitrogen, of sulphur, of silicon and other elements. Indeed, in the studies of Werner, already referred to, stereochemical phenomena are illustrated in many ways by compounds of platinum, palladium and other metals that enter into the complex inorganic bases.

Our imaginary atom then has mass. It has the power to combine with other atoms under the proper conditions. This power is either a unit, as in the univalent elements, or it is divisible by 2, 3, 4, 5, 6, 7 or 8 in the case of other elements. Further, one and the same element may exhibit different powers under different conditions, but the laws governing these variations are not known. Finally, the powers of combination of a polyvalent atom are exerted in definite directions that can to some extent be determined. These directions are evidently subject to variation, and some effect upon a compound caused by displacement has apparently been shown in the case of some carbon compounds; at least Von Baeyer's strain theory is based upon this assumption.

The latest turn that has been given to the conception of the atom brings in again the electric charge. It appears that the contemporaries of Berzelius were too easily frightened, and Berzelius was nearer right than they supposed. Every book on the history of chemistry has an obituary on the electrochemical theory of Berzelius. But now it appears that the electrical charges assumed by him must be assumed by us. These have come more and more to the front of late, and chemical union is being regarded more and more as due to the interaction of these charges. According to the modern conception, an atom may or may not be carrying a charge of electricity. When carrying its charge it is called an ion, and it is then ready for action. When the elementary ion gives up its charge, either by

entering into combination with another ion, or other ions, or by being set free, it becomes an atom. But more than this: The electrical charge of an ion is either a unit charge or a multiple of this. The bivalent ion has two charges, the trivalent ion has three, etc. The experimental basis for these ideas is found in the electrolytic phenomena that are included in the scope of Faraday's law. Faraday found that a definite quantity of electricity causes a definite amount of decomposition in a conductor of the second class; and, further, he found that when the same current is passed through solutions of the salts of different metals in series, the masses of the different metals that separate are proportional to the combining weights or the equivalents of these metals. To make clear the full significance of these facts would require more time than is at my disposal. Suffice it to say, that in terms of our present theory it takes twice as much electricity to set a bivalent atom free as to set a univalent atom free; three times as much for a trivalent atom, etc. How to conceive of one, two, three or four charges of electricity on an ion I leave to the physicists to explain, though it must be said that they are not in the least called upon to explain.

The atom has thus been followed in its career down to to-day. The changes in our conceptions have been traced sufficiently for our purpose. It is at present a bundle of attributes and with these attributes it is a convenient nucleus for thought. Nothing has been said of the dynamics of the atom, by which I do not, of course, mean chemical dynamics in general. So far as the atom is concerned our knowledge of its motions may perhaps fairly be summed up by saying that it seems probable that it moves in some mysterious way, and perhaps the phenomena of chemistry are all due to this motion. But that carries us into the region of speculation pure and simple, and in this region the scientific worker feels uncomfortable. The atmosphere is too rarefied for him.

If you now ask what is the soul of the doctrine of atoms? I can only answer that this soul is still in the course of development. The doctrine has some immortal attributes, but what will live after its death is too early for any one to say.

"Prove all things. Hold fast that which is good."

BIOGRAPHICAL SKETCHES.¹

BY M. I. WILBERT.

ALFRED BOWER TAYLOR.

Alfred Bower Taylor was one of those unassuming, hard-working individuals who, while they do not make strenuous efforts to achieve notoriety or empty honors while living, leave behind them, when they die, an enviable reputation for having followed the dictates of what they considered right, just and proper.

It may be well to preface our remarks with the necessary data, so that we can appreciate still more the disadvantages under which the subject of this essay labored in his endeavors to advance his own and the professional standing of his fellow workers.

Mr. Taylor was born in the city of Philadelphia on January 6, 1824. After graduating from the academic department of the University of Pennsylvania, in 1841, he engaged to learn the art and business of an apothecary with the late Henry C. Blair, who was located at the corner of Eighth and Walnut Streets. Mr. Taylor subsequently attended the lectures delivered at the Philadelphia College of Pharmacy, graduating in 1844. This class of '44, while not large in point of numbers, appears to have been made up largely of men who devoted much of their time toward advancing professional pharmacy, in preference to accumulating money, by devoting themselves strictly to the business interests of their calling.

After spending several years in New York City, Mr. Taylor returned to Philadelphia and established himself as a retail pharmacist. He continued in business for nearly thirty-five years, when he retired to devote the remaining years of his life to original research and literary work. Mr. Taylor died in his native city on February 28, 1898.

From what has been said it will be evident that it is not as a retail dealer in drugs and medicines that Alfred Bower Taylor will be remembered or referred to. On the contrary, it is rather as an unassuming, hard-working investigator and student, who was always willing to contribute of his vast store of knowledge to advance the professional standing and material welfare of his co-workers that he is to be remembered and honored by this and succeeding genera-

¹ The author will present from time to time sketches of those who have contributed to the welfare of American pharmacy.—EDITOR.

tions. In 1848, Mr. Taylor was elected an active member of the Philadelphia College of Pharmacy, and from that time to his death this institution was always foremost in his ideas, his ideals and his work. The actual amount of time and work that Mr. Taylor devoted to advance the position and standing of this college will never be known, and consequently can never be adequately appreciated. He was elected a member of the Board of Trustees the same year that he became a member of the college. Two years later he was elected to act as Secretary of the Board of Trustees. Mr. Taylor served in this capacity, and subsequently as Corresponding Secretary of the College, for a period of thirty-six years.

To bring to mind some of the important and arduous services that he rendered this institution, it is but necessary to recall the fact that he served for twenty-one years as a member of the Publishing Committee of the AMERICAN JOURNAL OF PHARMACY. That his connection with the JOURNAL was not one of empty honor is evidenced from the very complete index of the first twenty volumes, the work of Mr. Taylor, that appeared in 1850.

Mr. Taylor served for more than forty years as a member of the College Pharmacopœial Revision Committee, more than half of that time as chairman, so that a very large proportion of the very excellent work that this committee is known to have contributed was directly due to or was actually done by him.

An enumeration of the special committees on which he served would alone fill a number of pages of this JOURNAL. One of his more important services in this connection was as a member of the delegation sent by the Philadelphia College of Pharmacy to attend the convention of colleges in New York in 1851. As is well known, it was at this meeting that the Association, later known as the American Pharmaceutical Association, was conceived and the preliminary preparations made for its successful beginning at Philadelphia the following year. Mr. Taylor acted as secretary of this preliminary meeting, and much of the success of the inaugural meeting in Philadelphia was no doubt due to his energy in securing the proper publicity and bringing the necessity of such an organization to the attention of such as would be likely to be interested in it. As a member of the American Pharmaceutical Association, Mr. Taylor was not alone active in that he attended the meetings, but he also contributed much original matter of sterling worth to the proceed-

ings. He also served the Association in various official capacities, as its first treasurer, 1852-1854; local secretary, 1863 and president, 1890.

It is, however, as a member of the National Pharmacopœial Revision Committee that Mr. Taylor did his most important work, contributing much toward the gradual and successful evolution of that volume into a book of authority second to none for completeness and scientific worth.

As a contributor to the literature of American Pharmacy, Mr. Taylor must be classed with the leaders of his time. The papers from his pen are not alone numerous, but they also give evidence of much study and a complete mastery of the subjects under discussion. To show the wide variation in the lines of thought, it may be well to enumerate a few of the subjects that Mr. Taylor has discussed more extensively. A critical review of these various papers would readily convince any one how completely he had made himself master of the different subjects. Among the more interesting papers we may call to mind his contributions on Fluid Extracts, Cinchona Bark and the preparations made from it, Weights and Measures, and a proposed system of octonary numeration.

This latter subject is interesting in that it demonstrates how far Mr. Taylor was ahead of his contemporaries. It is now generally conceded that if it were possible to introduce an octonary system of numeration, the advantages accruing from such an innovation would more than repay any inconvenience that may be occasioned by its introduction. While it is improbable that any change in our system of enumeration will be made in the immediate future, nevertheless, a system of numeration in which round figures can be continually halved without leaving awkward and lengthy fractions, must be acknowledged to have merits not possessed by our present system of decimal notation. Nor could the oft-proposed and quite recently rejuvenated system of duodecimal numeration compare in efficiency or applicability with an octonal system. A comparison of the possible indivisible fractions will readily convince any one of the theoretical advantages possessed by the simpler multiplication by eights. The practical application of this theory, however, will be a problem for future generations to solve.

Altogether it must be said that Alfred Bower Taylor was not alone an able pharmacist, who was always ready to take advantage

of scientific progress, he was also a scientist, who had at heart the development and advance of the human family.

The concluding year of Mr. Taylor's life included periods of great physical suffering and mental privation; his eyesight failed him, depriving him of one of his most cherished pastimes—that of reading. He left behind him an unsullied record for constant and unremitting devotion to the best interests of his chosen profession.

MAURICE W. ALEXANDER.

The largest class that had ever graduated from the Philadelphia College of Pharmacy, up to that time, gathered at Musical Fund Hall, on April 18, 1854. According to the reporter of those days this class had the degree of Graduate in Pharmacy conferred on them by the then presiding officer of the College, Henry C. Blair, Esq. The ceremony was gone through with in the presence of a large and respectable audience, and was followed by a valedictory address by Prof. Robert P. Thomas.

Among the names of the twenty-six graduates we find a number that have become well known in the pharmaceutical world, their respective bearers having attained a considerable degree of success in their chosen profession.

The first name on the class roster is that of Maurice W. Alexander, who had chosen as the subject of his thesis one of the less-known plants belonging to the Labiatae—"Melissa."

After graduating from the Philadelphia College of Pharmacy, Mr. Alexander went to St. Louis, Mo., where he soon established himself as the proprietor of one of the best-known and most successful retail pharmacies.

Mr. Alexander took an active interest in all attempts to improve the status of the retail pharmacist, as is evidenced from his active interest in both the National as well as State Pharmaceutical Associations. He was also, for several years, a member of the State Board of Pharmacy of Missouri.

Mr. Alexander was particularly well known as an active member of the American Pharmaceutical Association. He joined that body at the St. Louis meeting in 1871, and for nearly thirty years was one of the most regular attendants at its annual gatherings. His wide experience gave him an opportunity of contributing much valuable advice, particularly in connection with the administration of the business affairs of the Association.

That his exertions for the welfare of the Association were appreciated, is evidenced from the fact that he was elected as second vice-president at the meeting in Providence, in 1886; first vice-president in the following year at Cincinnati, and at the Detroit meeting the next year he was elected president.

This steady progression is the more remarkable, as Mr. Alexander is the only president that was successively elected to these various offices, any one of which is usually considered sufficient honor for any particular services rendered the Association. In this connection it should also be remembered that all of these honors came to Mr. Alexander in cities more or less remote from his home, and must therefore be considered as being a tribute of appreciation for his work, from comparative strangers.

As President of the American Pharmaceutical Association, he had the honor of presiding over what is often spoken of as one of the most interesting as well as most successful of meetings—that at San Francisco, in 1889. Mr. Alexander also had the honor of being one of the incorporators of the American Pharmaceutical Association, the charter for which was taken out under the laws of the District of Columbia, at Washington, in 1888.

Maurice W. Alexander died at his home in St. Louis, on June 6, 1898, in the sixty-fifth year of his age. The feeling of loss that pervaded his fellow members of the Association is voiced in the sentiment expressed by the Secretary of the Committee on Membership who, in his report for that year, when referring to the death of Mr. Alexander said, "We cannot but miss the pleasant countenance of that dear old friend, who scarcely ever was absent from our annual meetings and whose high social standing won him the love and esteem of all. He was a man of unusual courage and his sound advice will be ever fresh in our minds. The extension of the good work of our Association, for which he labored so indefatigably, should never be forgotten but stand as a mark, by way of encouragement to others to do likewise."

PROGRESS IN PHARMACY.

A QUARTERLY REVIEW OF SOME OF THE MORE INTERESTING ADVANCES
IN PHARMACY AND MATERIA MEDICA.

BY M. I. WILBERT,
Apothecary at the German Hospital, Philadelphia.

THE NEW FIFTH EDITION OF THE RUSSIAN PHARMACOPŒIA has just been issued. According to the reviews of the same in the German pharmaceutical journals, it is far from being an ideal or perfect pharmacopœia, but it is nevertheless quite an improvement on any of the editions that have preceded it. Unfortunately perhaps for the general reader, outside of Russia, the Revision Committee has followed the example of other pharmacopœias, and has given all of the directions and descriptions in the vernacular. As Russian is a language that has interested but comparatively few scholars it will be seen that this pharmacopœia will not be readily available for reference, study, or comparison.

Assay processes are included for several of the drugs of organic origin. Cinchona is to be estimated gravimetrically, and is to contain at least 3.5 per cent. of alkaloids. Opium is to contain from 10 to 12 per cent. of morphine, also estimated gravimetrically. Many of the organic drugs are described in the powdered form. This will no doubt be appreciated by the practical druggist, as it furnishes him with an authoritative guide for the examination of powders as to their identity and purity.

This is the first national pharmacopœia that has been published since the meeting of the International Congress for the unification of potent remedies. According to the *Apotheker Zeitung* no changes have been made in the strength of galenical preparations, so that all of the preparations, for which international standards have been proposed, are practically included as they were in the last or fourth edition. These it will be remembered corresponded closely to the standards proposed by the International Congress.

INTERNATIONAL STANDARDS.—In reference to the proposed international standards it may be said that Prof. Dr. August Ritter von Vogl, in his report to the Austrian Government, says that the program as proposed by the Belgian Government and as finally adopted by the International Conference, agreed in all particulars with the proposed and fundamental principles as already adopted by the

Revision Commission for the new eighth edition of the Austrian Pharmacopœia; there was therefore no occasion for the Austrian delegates to take a very active part in the discussion.

The report of the British delegate, Dr. MacAllister, to the General Medical Council is also very promising, considerable satisfaction being expressed at the conservative way in which the International Congress was conducted, and the concessions that were gladly made to the demands of the British delegate. There appears to be no doubt that the British Pharmacopœia in its next edition, or possibly in an addendum, will incorporate the essential features of the proposed international standards for potent remedies.

As time rolls on the indications are more and more in favor of the general adoption of the recommendations of the International Congress.

ATOMIC WEIGHTS.—The International Atomic Weights Commission has recently published the revised table of atomic weights for 1903. (*Zeitschr. f. angewandte Chemie*, 1902, page 1305.) In view of the fact that considerable difference of opinion exists as to the practicability of the Oxygen or Hydrogen standard, the table is published in parallel columns based respectively on $O = 16$ and $H = 1$ as standard.

Among the new additions to the list of elements is Radium. This has been given the symbol Ra and the atomic weight of 225. The elements of the Argon Group have been reconsidered. Krypton is now given as having an atomic weight of 81.8 instead of 45, as given in a previous table.

Xenon is given an atomic weight of 128 instead of 65.

Of the elements more or less directly of interest to pharmacists the following have had their atomic weights redetermined or reconsidered:

Antimony: this is given as 120.2 instead of 120.

Iron: this is 55.9 instead of 56.

Mercury is 200 instead of 200.3.

Uranium, according to recent determinations of Richards and Merigold, should be 238.5 instead of 239.5.

Tin, according to the work done by Bongartz and Classen, should be 119 instead of 118.5. All of these atomic weights are given on the basis of $O = 16$ being equal to $H = 1.008$.

WEIGHTS AND MEASURES.—The possible misunderstandings that

may arise from and the incongruities of the system of weights and measures in use in English-speaking countries are well illustrated by the controversy that has been carried on in the *Pharmaceutical Journal* (London, 1902) as to what should be dispensed when a solid is prescribed by writing \mathfrak{z} j; several of the correspondents assert an ounce of 437.5 grains is intended, while others maintain that 480 grains is the only ounce to which the \mathfrak{z} sign is applicable.

TEST-PAPERS.—The *Pharmaceutische Centralhalle* (1902, page 416) describes a new test-paper, made by Dietrich, that has red and blue litmus in strips on the same paper. It is said to be prepared on a specially designed machine, and to prevent the possibility of the acid litmus affecting the blue strip, the two are separated by an isolating body like ceresin or paraffin.

The advantages of such a paper are, of course, that the two tests are made simultaneously. It is further suggested that the same idea could be so elaborated that three or more test-papers could be combined, in this way facilitating the testing of a number of solutions.

DETECTION OF CURCUMA IN POWDERS.—For this Albert E. Bell (*Phar. Jour.* 1902, page 551) recommends the use of diphenylamine as a reliable test, curcuma giving with this test a reddish-purple color not given by any other vegetable substance, so far as known to the writer. Bell prepares the test-solution as follows:

Diphenylamine, 1 gramme; alcohol, 20 c.c.; sulphuric acid, 25 c.c.

One drop of the reagent is put on a slide, placed under the microscope and then, by means of a glass rod, a small quantity of the powder to be tested is added. As little as 1 in 200 of curcuma in rhubarb and 1 in 100 of curcuma in mustard were detected by Mr. Bell.

OINTMENTS.—The *Pharmaceutische Centralhalle* (1902, page 605) calls attention to the separation of ointments containing insoluble ingredients, especially ointments made with petrolatum. On standing these ointments have a tendency to separate; it is advisable, therefore, that ointments should be repeatedly mixed, especially before dispensing, so as to insure their homogeneity.

MERCURIC OINTMENT.—To determine the amount of mercury in this ointment G. Pegurier (*Phar. Zeitg.*, 1902, page 956, from *L'Union Phar.*) recommends weighing an accurately measured quantity of

the ointment and then weighing the same quantity of the ointment base, or of a mercuric ointment of known mercury content; the difference in weight would indicate the per cent. amount of mercury.

For testing the non-volatile materials, used as adulterants, such as powdered slate or powdered coal, the same writer heats a portion of the ointment to redness in a porcelain dish. Genuine mercuric ointment is completely volatile.

FORMALDEHYDE IN MILK, test for.—Manget and Marion (*Four. de Phar. et de Chem.*, 1902, page 532) say that if a minute quantity of amidol or diamidophenol be sprinkled on the surface of the suspected milk it will assume a bright-yellow color, while pure milk assumes, after a few moments, a salmon pink. This reaction is said to be a sensitive one, as little as 1 in 50,000 of formaldehyde still giving the reaction very distinctly.

SULPHUROUS ACID in dried fruits. Marpmann (*Süd. Deutsch. Apothek. Zeitg.*, 1902, page 881) gives the results of a number of examinations of dried fruits immediately after being opened, two days later, and also after being exposed to the air for eight days. He also gives the results of another series of experiments before and after washing with water. Marpmann concludes that the addition of sulphur fumes does not injure the fruit—on the contrary tends to preserve it. By prolonged exposure to air or through washing in water it is possible to eliminate all traces of the acid or its salts. The thorough washing of dried fruits is recommended in all cases.

FICTITIOUS MACE.—At a recent meeting of the Liverpool Chemists' Association Mr. J. H. Wardleworth (*Chem. and Drug.*, 1902, page 1002) exhibited a sample of fictitious mace which had been cleverly treated with aniline dye to make it resemble the genuine. This fictitious or Malabar mace shows very little difference in structure microscopically, but is entirely devoid of taste or odor.

ARSENIC IN POTASSIUM CARBONATE.—C. E. Carlson (*Phar. Central-halle*, 1902, page 617) reports that a lot of crude potassium carbonate that he examined contained appreciable quantities of arsenic. The salt was of German origin, and was supposedly obtained from the wool washeries. In view of the extensive use of potassium carbonate by bakers and others the possible dangers are self-apparent.

OCCURRENCE OF ARSENIC IN THE ANIMAL ORGANISM.—Gautier (*Compt. Rend.*, 1902, page 1434) reports finding arsenic in various organs and parts of animals, particularly in those portions contain-

ing keratin, such as the bristles of the hog, feathers of geese, horns of oxen and the hair and nails of dogs.

The arsenic content appears to be cumulative, particularly when accompanied by keratin, as Gautier demonstrates that the various portions of older animals contain more arsenic than the younger.

CINEOL ARSENATE.—This is said to be a stable combination, made by adding an aqueous solution of arsenic acid to oil of eucalyptus. When freshly prepared it is white, with crystalline characteristics. Gradually heated cineol arsenate melts at 95° C. It is soluble in alcohol or ether, but decomposed into its constituents by water. (*Phar. Centralhalle*, 1902, page 651.)

HOPOGAN.—According to the *Chemist and Druggist* (1902, page 846) this is but another tradename for magnesium dioxide or biogen.

DERMOGEN is the corresponding salt of zinc, consisting of a variable mixture of zinc oxide with zinc dioxide. It is recommended as a local application, as a dusting powder or in ointments.

HELMITOL.—This is a formaldehyde compound that has been recommended as an improvement on hexamethyltetramin. Chemically, it is said to be the methylencitrate of hexamethyltetramin. It is to be given in doses of 1 gramme two or three times a day. (*Apothek. Zeit.*, 1903, page 43.)

METHYLATROPINE BROMIDE.—This is said to possess several advantages over simple atropine; it is soluble in water or dilute alcohol. Two drops of a 1 per cent. solution instilled into the eye are said to dilate the pupil, and that the effect of this dilation wears off within four hours.

Doses of 0.005 to 0.010, given once a day, are said to control the night sweats of phthisis without any of the secondary effects noticeable with atropine or any of the other preparations of belladonna. (*Apoth. Zeit.*, 1903, page 42.)

OXYGEN.—An apparatus for generating chemically pure oxygen from tablets or pastilles of sodium dioxide is figured and described on page 672 of the *Pharmaceutische Centralhalle* (1902).

This apparatus is being put on the market by an Austrian firm, under the tradename, oxygenophor (oxygen generating apparatus). It is quite simple of construction, consisting of a metallic vessel having three divisions, the lower of which contains the sodium dioxide, the middle one containing water, and the upper one also containing water with which to wash the liberated gas.

In operation a needle-valve allows a minute quantity of water to drop from the middle division onto the sodium dioxide contained in the lower compartment; this liberates a corresponding amount of oxygen gas, which passes up through a vent-tube into the upper compartment where it is cooled and washed by passing through the contained water. Each 25 grammes of the sodium dioxide liberates 3.5 litres of oxygen.

HYDROGEN DIOXIDE SOLUTION may be made according to Paul Léon Hulin (*Zeitschr. f. angew. Chemie*, 1902, page 600) by adding, with caution and at a low temperature, sodium dioxide to a solution of fluoric acid, producing hydrogen dioxide and sodium fluoride. This solution is then treated with aluminium fluoride, thus producing insoluble cryolite, the well-known double fluoride of aluminium and sodium.

HYDROGEN DIOXIDE as an addition to cosmetics and creams. H. Kuhl (*Apoth. Zeit.*, 1903, page 81) gives a number of formulas. Among others, for a toothpaste, precipitated carbonate of lime 25, powdered soap 5, glycerin and solution of hydrogen dioxide of each sufficient to make a paste; perfume with oil of bergamot, oil of peppermint, or oil of lavender.

Glycerin mixture; glycerin 40, rose-water, solution of hydrogen dioxide of each, 20. (A more efficient, certainly more economical preparation would be obtained by adding sufficient tragacanth to make a jelly-like paste.)

For a skin-cream, Kuhl recommends to saturate lanolin with solution of hydrogen dioxide.

HYDROGEN DIOXIDE AS A DEPILATORY.—L. Gallois (*Med. Presse*, 1902, page 438) finds that the simple application of hydrogen dioxide solution is a simple and efficient way of removing superfluous hair. A piece of absorbent cotton moistened with the solution is repeatedly applied to the region to be epilated. The hair at first becomes bleached, finally becomes brittle and breaks off. This method appears to offer many advantages over the means usually employed, such as shaving, electrolysis or caustic applications. Its simplicity and comparative harmlessness would appear to warrant a trial in cases where a depilatory would be applicable.

THEOBROMINE in leaves of *Theobroma cacao*.—J. Decker (*Schweiz. Wochens. f. Chemie u. Phar.*, 1902, page 569) has examined a number of leaves of cacao and found that old leaves contain but a trace of

theobromine, while the younger leaves contain from 0.29 to 0.55 per cent. of the alkaloid.

Decker also examined a number of leaves of the Kola tree; he found no caffeine in the old leaves, while young leaves contained as much as 0.049 per cent. of caffeine and 0.101 per cent of theobromine.

RHEIN FROM EMODIN.—Oesterle (*Schweiz. Wochens. f. Chemie u. Phar.*, 1902, page 600) publishes some further experiments he has made with di- and trioxymethyl-anthraquinone, emodin and chrysophanic acid, respectively. From the emodin, di-oxy-methyl-anthraquinone he claims to have made a crystalline principle analogous to Rhein, tetra-oxy-methyl-anthra-quinone.

COLOMBO, ALKALOIDS IN.—Dr. Gadamer (*Apoth. Zeit.*, 1902, page 690) says that colombo root contains at least two alkaloids somewhat resembling, but not identical with, berberine. These colombo alkaloids are yellow and are readily reduced to colorless hydro compounds, which are soluble in ether. Berberine itself is not found in colombo.

These colombo alkaloids are said to be quarternary bases, while the reduction compounds, or hydro combinations, are tertiary.

RED MERCURIC OXIDE, a new wet method of preparing.—R. Dufan contributes the following: 125 grammes of potassium carbonate are dissolved in 500 grammes of water and heated to boiling; 100 grammes of mercuric chloride are dissolved in 1,875 grammes of water. This latter solution is gradually added to the boiling alkali solution without discontinuing the heat.

The resulting amorphous powder is then washed, to free it from chlorides, and finally dried. The process gives an orange-yellow crystalline powder that is said to combine the good properties of both red and yellow oxides, without any of their disadvantages (*Süddent. Apoth. Zeit.*, 1902, page 836, from *Rep. d. Phar.*)

ANTISEPTIC HEMOSTATIC.—The German pharmaceutical journals publish the description of a patent granted to R. Rhode, Breslau, for a preparation having the following composition: 50 grammes of powdered alum, 10 grammes of borax, 10 grammes of glycerin, 5 grammes of zinc oxide and 10 grammes of formaldehyde solution are melted together and poured into suitable molds. The combination, it is asserted, gives an efficient hemostatic that is at the same time antiseptic and promotes healing.

ALUMINIUM VESSELS PLATINIZED.—A. Gawalowski (*Zeitschr. f. Anal. Chem.*, 1902, page 618) describes a method of readily platinizing aluminium vessels so as to make them available for evaporating water for chemical analysis. To the bright, polished inner surface of aluminium vessels he applies an alkaline solution of platinum prepared by adding sufficient of a caustic potash solution to a 5 or 10 per cent. solution of platinum chloride until the latter is slightly alkaline in reaction, to phenolphthalein solution.

Platinized aluminium vessels should not be cleaned by scrubbing with sand, but may instead be rinsed with a 5 or 10 per cent. solution of oxalic acid.

ALUMINIUM, increase in density and ductility of.—According to a German patent, granted to W. Rubel, the addition of from 3 to 15 per cent. of phosphorous to metallic aluminium changes the physical properties of this metal to such a degree that it becomes applicable to quite a variety of purposes, for which, on account of its soft character, it has not been used.

PHYTOTHERAPY.—According to the *Süddeutsche Apotheker Zeitung* (1903, page 39) this is the latest pseudo-medical fad, and according to its promoters, embodies the most recent methods of combating diseases by means of non-poisonous plant extracts.

"Not only do these plant extracts eliminate all natural poisons from the human organism, but also remove or counteract the havoc made in the human body by the poisonous medicines used by allopathic physicians."

REVIEWS AND BIBLIOGRAPHICAL NOTICES.

Die Rohstoffe des Pflanzenreiches. Versuch einer Technischen Rohstofflehre des Pflanzenreiches unter Mitwirkung von Prof. Dr. Max Bamberger in Wien; Dr. With. Figdor in Wien; Prof. Dr. F. R. v. Höhnelt in Wien; Prof. Dr. T. F. Hanausek in Wien; Prof. Dr. F. Krasser in Wien; Prof. Dr. Lafar in Wien; Dr. Karl Linsbaur in Wien; Prof. Dr. K. Mikosch in Brünn; Prof. Dr. H. Molisch in Prag; Hofrat Prof. Dr. A. E. v. Vogl in Wien; Prof. Dr. K. Wilhelm in Wien und Prof. Dr. S. Zeisel in Wien, von Prof. Dr. Julius Wiesner in Wien. Leipzig: Verlag von Wilhelm Engelmann. 2 Bde. pp. 1865, M. 60; gebunden M. 66.

The second edition of Wiesner's "Rohstoffe des Pflanzenreiches"

has been finally completed with the issuance of parts II and 12 and the index of the entire work, which have just come to hand. Professor Wiesner has written the introductory as well as the chapters on gums, resins, starches and fibres; all the remainder has been the work of a dozen colleagues connected with the various German universities and who are well known for their researches on various raw materials of the vegetable kingdom.

It may be useful to mention briefly the contents of this important work on "raw materials of the vegetable kingdom." Part I contains an able introduction by Dr. Wiesner and also a chapter on gums by Wiesner and Zeisel, in which are considered the natural history, physical and chemical characteristics, constitution, origin in the plant, enumeration of plants yielding gums and a special consideration of ten important commercial gums.

Chapter II is devoted to the consideration of resins by Wiesner and Bamberger, which is characterized by the same thorough detailed and interesting treatment as the chapter on gums, twenty-two important commercial resins being considered in detail. Chapter III is on the caoutchouc group and is the work of Molisch, who treats of the caoutchouc-yielding plants, the nature of milk-vessels and milk-juices, and especially considers caoutchouc, gutta-percha and balata. Opium and aloes have been exhaustively considered by Vogl in Chapters IV and V, and Molisch has taken up the subject of indigo in Chapter VI, which is one of the most interesting chapters in the work. Mikosch, in Chapters VII, VIII and IX has written upon the catechu group, including catechu, gambir and kino, and the vegetable fats and waxes. The latter subjects are particularly instructive, as they are considered not only in a chemical sense, but in their botanical relationships. The chapter on camphor by v. Vogl, while it might have been enlarged, nevertheless contains considerable authentic information. Chapter XI is devoted to the consideration of starches by Wiesner and Zeisel and is a treatment of the origin and constitution of starch, the preparation of commercial starches, including the special study of twenty-one different commercial starches. Lafar has an interesting chapter on yeasts. Krasser considers in Chapters XIII and XIV the economical algæ and lichens. Chapter XV embodies an interesting monograph on galls, including their origin, natural history, chemical characteristics and a detailed study of the galls on species of

Quercus, Pistacia, Rhus and *Tamarix*. The barks are treated by v. Höhnelt in Chapter XVI, and he has devoted over fifty pages to the detailed study of twenty-one different commercial barks. While pharmacists will be particularly interested in the treatment of cinchona, cinnamon and quillaja, others will be as much so in the information on the barks of various oaks, hemlocks and other coniferous trees.

The chapter on woods by Wilhelm is one of the most complete and thorough in the book, and this, together with the chapter on barks, furnishes an excellent preparation for the study of Chapter XVIII, which is devoted to the consideration of fibres by Wiesner. The 750 pages devoted to the woods, barks and fibres form probably the most instructive monographs on these subjects, and will be referred to for years to come by all those who are able to comprehend the exhaustive scientific researches pertaining to these subjects and their application in every industrial operation in which these materials or their products may enter.

Chapters XIX-XXIII are devoted to the consideration of roots and rhizomes by v. Vogl; leaves and herbs by Krasser; flowers and parts of flowers by Linsbauer, and seeds and fruits by Hanausek. All of these are of particular interest to the pharmacist, as in these chapters are exhaustively considered, among other commercial products, calamus, ginger, orris root, Spanish saffron, cloves, insect flowers, rose petals, jasmin flowers, nutmeg, mace, tonka, flaxseed, ricinus, vanilla, hops, illicium, etc.

This new edition of Wiesner's "Die Rohstoffe" is no doubt the most important technical work in this line that has appeared in recent years. It is a new book, modernized in every essential and written by men who have thoroughly comprehended the importance of scientific researches in the study of every product of the vegetable kingdom that is utilized in the arts. Those who are interested in woods, barks and fibres; or gums, resins, starches, fats, waxes, caoutchouc products and the like; or tannins, opium, aloes, indigo, yeasts, etc.; or products to be used for foods, medicine, perfumery, as well as other economic purposes, will find the book invaluable. No reference library of a pharmaceutical school, medical college, or technological institution will be complete without this book, and when we consider the low price at which it is offered, viz: fifteen dollars, we may say that every one who is utilizing products of the vegetable kingdom ought to possess the book for ready reference and careful perusal whenever opportunity affords.

A TEXT-BOOK OF QUANTITATIVE CHEMICAL ANALYSIS. By Frank Julian. Octavo 600 pages, illustrated. The Ramsey Publishing Company, P. O. Box 3, St. Paul, Minn. \$6.

In this work the author aims to consider the principles underlying quantitative analysis, it being devoted to the consideration of the following subjects: Part I. Introduction, sampling, preparation of the sample for analysis, the balance and weights, the operations of analysis, weighing the sample, solution, evaporation, distillation, precipitation, separation, filtration, washing precipitates, ignition, volumetric analysis, gasometry, attributive methods, calculation of analyses, errors and precautions. Part II. Reagents, exercises in the analysis of alcohol, lead carbonate, ferrous sulfate, sodium chloride, coffee, ginger, cast-iron, ether, standard acid and alkali, vinegar, lemon-juice, chloral hydrate, acetic acid, hydrastis, guarana, standard permanganate, potassium chlorate, forge scale, chrome-yellow, metol, sodium thiosulfate, steel, galena, barium chloride, lard, potassium permanganate, air, ammonium sulfate, nickel-copper alloy, wollastonite. Part III is devoted to special methods and technical analysis and includes colorimetry, the fire assay, electrolysis, the metals and common acids, ultimate organic analysis, proximate organic analysis, chlorimetry, iron and steel, iron-ores, coal, natural water, fertilizers, the alcohols, glycerol, the alkaloids, the tannins, the carbohydrates, the oils and fats, soaps, milk and butter, urinalysis and the organic dyestuffs.

In Part III is also considered the analytical behavior of a number of articles of commercial importance. Part IV contains notes on the methods of analysis, and the appendix contains tables, notes on technical and industrial analysis and an index.

The subjects are well presented and free from ambiguity. The book is full of valuable information and one to be commended to analysts and students alike.

SUGGESTED STANDARDS OF PURITY FOR DRUGS AND FOODS. By C. G. Moor. London: Ballière, Tindall and Cox. 8 Henrietta Street, Covent Garden, 1902.

This work of Mr. Moor's embodies an interesting discussion of analytical results and has primarily to do with their interpretation. In the consideration of the drugs and preparations of the British Pharmacopœia the pharmacopœial definition is given, but instead of giv-

ing the B. P. description, the author discusses prominent characteristic features and the analytical standards suggested, supplementing the latter with tables showing the results by various investigators. Citations to important literature are given in connection with the various subjects taken up.

In addition to the drugs and preparations of the British Pharmacopœia, the work is devoted to the consideration of various foods, as butter, coffee, flour, ice-cream and ices, infant foods, jam, meat preparations, preservatives, vinegar, aerated water, etc. In the treatment of these subjects, as of drugs, the author has shown good judgment and his suggestions are particularly valuable.

There are a number of works treating of analytical methods and which contain the results of analyses, but this work is unique and supplies a most important want in the correlation of the works of various investigators, together with a discussion of the standards suggested.

NOTES ON PHARMACOGNOSY. Second edition, revised and enlarged by Otto A. Wall, Ph.G., M.D. St. Louis: Aug. Gast Bank Note and Litho. Company, 1902.

The author states in his preface that "these notes are intended to take the place of notes which a diligent student might possibly write down for himself, so that during lectures he can give undivided attention to the words of the lecturer and to the illustrations and specimens shown." The author further states that "these notes serve as a skeleton of the science of pharmacognosy, presenting only those main facts which a student should make an effort to remember." "The system adopted is based on the general principles of modern pharmacognosy as established and first published in Europe by Schleiden and Berg, and in this country by Maisch, but in many details the arrangement is original."

After a general consideration of the subject the author gives an outline of the classification of drugs according to physical characteristics and, beginning with animal drugs, he proceeds to the consideration of various cryptogams, then to roots, etc., until finally various constituents, as acids, juices, extracts, etc., are taken up. In the introduction to vegetable drugs the author considers some of the principles underlying botany and microscopical technique. A large number of illustrations are distributed throughout the text, and these are largely the work of the author.

A MANUAL OF MATERIA MEDICA AND PHARMACOLOGY. Comprising all organic and inorganic drugs which are or have been official in the United States Pharmacopoeia, together with important allied species and useful synthetics, especially designed for students of pharmacy and medicine, as well as for druggists, pharmacists and physicians. By David M. R. Culbreth. Third edition, enlarged and thoroughly revised, with 473 illustrations. Philadelphia and New York: Lea Brothers & Co.

This book has been favorably reviewed on two former occasions in this JOURNAL and needs no extended review now. The third edition has been revised and some new matter has been added. Several new illustrations have been made, as of cola, cereus, scopola, saw-palmetto, etc., thus bringing the work up to the new additions of the 1900 U.S.P. The book has been carefully edited, and is like a condensed dispensatory containing information of all kinds on the vegetable, animal and chemical drugs considered. It is one of the few books that treats of the origin of generic and specific names, information concerning which students and others are not infrequently desirous of ascertaining. The work is bound in garnet and as a whole is pleasing in appearance.

OBITUARY.

The death of Mr. Jacob L. Smith, on the twenty-eighth day of last December, removed the oldest member of the College. He was born in the latter part of the year 1822 and educated at the school of Charles Keyser, the Friends' school now known as the Penn Charter School. He learned the drug business with Messrs. Samuel & William P. Troth, and was graduated by the Philadelphia College of Pharmacy in 1843. He immediately connected himself with the College, and in the following year he was elected a member of the Board of Trustees, serving until the year 1861. In the year 1849 he entered the employment of Messrs. Rosengarten & Denis and continued with the house, now Rosengarten & Sons, Inc., until his death, a period of fifty-three years and eight months. He was the "beloved friend of three generations of the Rosengarten family." Mr. Smith was a member of the Episcopal Church and was a vestryman for over fifty years, and actively engaged in the Sabbath schools of this Church during this long term. T. S. WIEGAND.

PHARMACEUTICAL MEETING.

The regular monthly pharmaceutical meeting of the Philadelphia College of Pharmacy was held Tuesday, February 17th, Mr. E. M. Boring, a member of the Board of Trustees, acting as chairman. Considering the practical value of the papers presented, the meeting was one of the most interesting of the present series.

The first paper on the program was on "Inferior Drugs and Artful Methods of Deception," by Lyman F. Kebler, chief of the new drug laboratory of the Department of Chemistry of the U. S. Department of Agriculture. The speaker first alluded to the variation in quality of drugs, collected at different seasons of the year, and of these he mentioned podophyllum and sanguinaria. He then considered a number of specific instances of inferiority. Mr. Kebler said that large quantities of the siftings of a number of drugs as cinchona, senna and cinnamon are available, and these are utilized chiefly in the manufacture of powdered drugs. A number of drugs lose their active principles on keeping. He found, for instance, that pilocarpus, which assayed 0.21 per cent. of alkaloids in May, 1901, was nearly devoid of any alkaloids a year and a half later. Sandalwood chips appear to be another drug in which the time-element is of importance. The old chips he found in one instance to yield but 1.2 per cent. of volatile oil, whereas a sample of fresh material yielded 5.5 to 6.0 per cent. of oil.

Mr. Kebler said that he recently had met with a sample of beeswax which closely resembled the genuine article, but which probably contained no beeswax at all. It had specific gravity 0.963, melting-point 64° C., acid number 6.1, ether number 134. He said that much of the beeswax on the market was composed of ceresin or paraffin, and that recently a flavoring liquid had been introduced to give these an odor of beeswax. In conclusion the speaker alluded to a reprehensible practice among some dealers in that they deliver goods which are either entirely different or much inferior in quality compared to the original samples submitted. Another unfortunate condition is, that the public have been educated to expect articles to have a certain appearance, as coated ginger, silvered cochineal, limed nutmegs, etc., and that they will not accept or are prejudiced against the genuine article.

In discussing the adulteration of beeswax Mr. H. J. Watson said that about 95 per cent. of the apiarists use artificial foundations,

which would account to a certain extent for the inferiority of the beeswax obtained direct from the hives. Mr. Kebler also called attention to the fact that he always found stearic acid in certain brands of beeswax. Mr. Boring emphasized the desirability of the pharmacist labeling all articles correctly, as for instance when cottonseed oil is supplied instead of genuine olive oil, etc.

Dr. L. Napoleon Boston presented a paper on "The Microscopic Study of Urine, Technique for Permanent Mounts and Method of Making Records," and a number of microscopic slides were exhibited in connection therewith (see page 111). Dr. Boston said incidentally, that the time was coming when every pharmacist will be expected to be able to make microscopic examinations of urine. He said that books with plates are of little value in this connection, and that it is better to make permanent mounts and study them.

A résumé of the advances in pharmacy and allied subjects during the last three months was given by M. I. Wilbert (see page 136).

Mr. Fred. W. Haussmann read a paper on "Notes on Syrups" (see page 108). In the discussion on this paper Mr. Matusow said if we follow the directions of the U.S.P. in the preparation of syrup of iodide of iron that it will eventually darken, whereas the presence of a small amount of hypophosphorous acid would prevent this; he therefore did not entirely agree with the statement of the speaker in regard to the darkening of the syrup as being due to caramelization. In speaking of salts of the hypophosphites, Mr. Kebler said that they were quite variable and sometimes contained impurities not recognized by the U.S.P.

On behalf of Dr. William J. Schieffelin, Professor Remington presented a very large specimen of crystals of cocaine hydrochlorate. Williams, Brown and Earle made an exhibit of a number of slides by means of their new projection lantern with polariscopic attachment. In this connection Professor Remington showed some colored lantern slides which he had received from Prof. Otto A. Wall, St. Louis, which had been prepared by the Misses A. C. Boefer and C. A. Burkart. A hearty vote of thanks was tendered the speakers and those presenting specimens.

H. K.